Oral burning: local and systemic connection for a patient-centric approach

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Abstract

Burning symptoms in the oral cavity are caused by a range of systemic and local factors, in addition to the neuropathic pain disorder burning mouth syndrome (BMS). Patients may state oral burning as a standalone symptom or may report as a secondary symptom in association with other factors, most commonly with oral dryness, oral mucosal lesions, or certain systemic conditions. There is a level of uncertainty in the presentation of this condition which creates a diagnostic challenge from both the patient's perspective and the practitioner evaluating these individuals. The diagnoses are complicated due to the lack of a clear definition of BMS and clinical guidelines to distinguish BMS from other conditions that are responsible for oral burning symptoms. A clinician should be able to differentiate oral burning from burning mouth syndrome. This integrative review discusses on local and systemic etiologies of oral burning based on current evidence that needs to be excluded for a diagnosis of BMS. It also provides an algorithm for diagnostic workup and therapeutic management to medical providers for patients experiencing oral burning symptoms. This comprehensive system provides a systematic stepwise workup in diagnosing and managing patients presenting with a complaint of oral burning that optimally meets a predictive, preventive, and personalized medicine (PPPM) approach.

Keywords Oral burning · Burning mouth · Xerostomia · Predictive preventive personalized medicine

Introduction

Oral burning or burning mouth is an unpleasant sensation characterized by chronic discomfort in the oral cavity. Oral burning symptoms have been documented in medical literature dating back to the early nineteenth century [1]. Oral burning symptoms are more prevalent among middle-aged and older, female patients than other population groups. Epidemiologic prevalence of BMS has been estimated to vary from 0.14 to 5% [2, 3] in the general population, and postmenopausal women have the highest documented in-

cidence of oral burning [4]. However, an exact estimate of patients who experience oral burning from other systemic or local causes has been indeterminate. The causes for the burning sensations of the tongue, gums, palate, and other areas of the mouth can be challenging to identify. Oral burning can arise from various factors associated with the presentation of the condition. There may be known triggers such as traumatic injuries to oral structures, oral lesions, oral infections such as candidiasis, oral dryness, or an underlying involvement of systemic diseases such as diabetes, nutritional deficiencies, or neuropathic changes that can make one feel the sensation of a burn with no apparent reason. Etiology of oral burning can range from local factors inside the oral cavity to systemic diseases affecting the oral cavity. Psychological and psychiatric comorbidities are prevalent in a significant number of patients experiencing oral burning [5]. The evaluation of oral burning is complex and needs a systematic approach. Management of the condition involves addressing the underlying cause of oral burning when possible, and often a diagnosis of

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exclusion may lead to burning mouth disorder that responds to a combination of neuropathic and palliative medications to alleviate symptoms. This integrative review focuses on the diagnosis and management of oral burning with the possibility of separating oral burning from BMS. A stepwise predictive, preventive, and personalized strategy on workup and management of a patient presenting with a complaint of oral burning was developed after summarizing past empirical and theoretical literature on possible etiological factors, comorbidities, therapeutic interventions, modalities, and management strategies.

Etiopathological factors and comorbidities

The spectrum of symptoms described by patients with oral burning can vary depending on the underlying cause of oral burning [6]. A complaint of oral burning should not be attributed to burning mouth syndrome, as the latter is often a diagnosis of exclusion [7]. A wide range of intraoral, extraoral, and

systemic factors may be associated with oral burning, described as follows.

Local factors and comorbidities

Local factors such as oral lesions—bacterial, viral (herpetic lesions), or fungal (oral candidiasis)—mucocutaneous lesions (oral lichen planus, vesiculobullous lesions, etc.), contact allergy, lichenoid lesions, oral parafunctional oral habits, trauma, and xerostomia may present with a secondary complaint of the oral burning sensation. If patients are not aware of the presence of lesions, the oral burning sensation may present as a chief complaint. Patients may also present with oral burning unaccompanied by visible oral mucosal lesions in cases of burning mouth syndrome. Hence, a differential diagnosis requires the exclusion of oral mucosal lesions or blood test alterations that can produce a burning mouth sensation to conclude a definitive diagnosis of primary burning mouth syndrome. Table 1 enumerates possible associations of oral burning with local etiological factors, its clinical presentations, and approaches in management.

Table 1 Local factors associated with oral burning

Local factors	Etiology	Associated clinical presentation	Approaches in management
Trauma:	Mechanical, chemical, thermal	Identify the cause from history; intraoral examination may reveal for possible traumatizing factors such as fractured restoration and ill-fitting denture	<ul style="list-style-type: none"> • Evaluate and treat the underlying cause • Symptomatic management with topical local anesthetic • If the area is ulcerated a short course of topical steroid may be helpful • Reevaluate for prognosis
Parafunctional habits	Cheek sucking, tongue thrusting, clenching	Identify the cause from history; intraoral examination may reveal clinical evidence of parafunction such as frictional keratosis [Fig], scalloped lateral border of tongue [Fig], or prominent linea alba	<ul style="list-style-type: none"> • Evaluate and treat the underlying cause • Symptomatic management with topical local anesthetic • If the area is ulcerated, a short course of topical steroid may be helpful • Habit breaking appliances/ oral splints • Reevaluate for prognosis
Oromucosal lesions	Bacterial, fungal, viral, and mucocutaneous lesions, lichenoid reactions	Identify the cause from history; intraoral examination may reveal a characteristic pattern pertinent to the condition	<ul style="list-style-type: none"> • Biopsy/ smear for confirmative diagnosis • Corresponding management for the underlying condition • Symptomatic management with topical local anesthetic • Reevaluate for prognosis, if chronic condition needs active management by respective experts
Salivary dysfunction and oral dryness	Decrease in salivary quality or quantity or both with diminished resting saliva or salivary gland hypofunction or atrophy	Fissured tongue, dry mucosa, diminished salivary flow	<ul style="list-style-type: none"> • Evaluate and treat the underlying cause • Over-the-counter emollients to improve lubrication • Symptomatic management with topical local anesthetic • Secretogues may be added based on etiology and salivary function and as tolerated by the patient • Reevaluate for prognosis

Trauma

Some oral burning may be transient after eating hot or spicy food that self-resolves in a few hours. Consuming extremely hot underestimating the temperature can cause traumatic injury to the mucosa; often, it may be palate or tongue due to the first contact. The presentation is usually an acute incident leading to a reversible injury to the tissue. A first-degree injury may involve a superficial layer of the oral mucosa often presenting with erythema and hyperalgesia associated with the burn which tends to heal within a few days of the injury [8]. A second-degree burn may take slightly longer to recover. A third-degree injury may affect deeper layers of the mucosa, with severe erythema with a possibility of scarring. If such injury involves nerve, there is a possibility of an increased response to the nerve resulting in pain with a burning sensation [9]. The symptoms may be persistent even after tissues have healed with trauma leading to peripheral traumatic trigeminal neuropathy.

Oral parafunctional habits

Patients with chronic bruxism, clenching, and tongue rubbing against teeth may develop oral burning sensation. Bruxism, myofascial pain of the muscles of mastication, and temporomandibular disorders have been documented as comorbidities with oral burning [10]. Figure 1 demonstrates a patient presenting with unilateral oral burning, accompanying a history of bruxism. An intraoral exam reveals wear facets of lower teeth and tongue displaying focal white plaque-like areas

Fig. 1 A 23-year-old female representing with unilateral oral burning, with history of bruxism and intraoral exam revealing wear facets of lower teeth and tongue displaying focal white plaque-like areas consistent with friction and irritation from sharp margins of teeth

consistent with friction and irritation from sharp margins of teeth. Often correcting the underlying etiology has good prognosis minimizing the oral burning. Figure 2 shows the scalloping of the lateral border of tongue characteristics of severe clenching.

Oral lesions

Oral mucosal lesions such as oral infections, (oral candidiasis, herpetic stomatitis) mucocutaneous lesions (oral lichen planus, oral mucositis, vesiculobullous lesions), and other oral mucosal reactions as contact allergy, hypersensitivity, and lichenoid reactions are often associated with oral burning [11]. Figure 3a shows a patient presenting with oral burning. Although that was the primary complaint, a thorough intraoral exam revealed erythematous labial mucosa, on careful reviewing the history which prompted the use of cinnamon-based triggers. On withdrawal, the level of improvement is as shown in Fig. 3b. The oral mucosa often presents with a classic presentation pertinent to the condition commonly appearing as erythematous and inflamed, and lesions may present in association with white lesions or erosive lesions or ulcerations [12, 13]. Such lesions associated with oral burning show favorable prognosis to the management of the underlying pathology. Figure 4 demonstrates an 81-year-old female patient presenting with complex oral burning, particularly the tongue. The intraoral examination of the tongue presenting with areas of de-papillation was consistent with the clinical features of benign migratory glossitis. Tongue coating on the dorsal tongue was positive for *Candida albicans*. Benign migratory glossitis (geographic tongue) is often asymptomatic but may be symptomatic causing a burning

Fig. 2 A 21-year-old female patient presenting oral burning on the lateral border of tongue, with the lateral tongue presenting a scalloped appearance, while focusing on history which revealed a persistent clenching and parafunctional oral habit

Fig. 3 **a** A 57-year-old female presents with lip and oral burning that is episodic; intraoral exam reveals erythematous areas of upper labial mucosa. History revealed that the patient had consumed a drink with sweet vermouth that is rich in cinnamon indicative of a lichenoid reaction on contact. **b** Decrease in erythema in 6 weeks after avoiding the food trigger without active treatment

Fig. 4 An 81-year-old female with complex oral burning; tongue presenting with areas of depapillation with features of benign migratory glossitis and tongue coating that was positive for *Candida albicans*

sensation when it is associated with secondary factors such as candida or neuropathy [14].

Oral dryness

Oral dryness is multifactorial with a wide range of etiological factors. Generally, oral dryness may be due to a quantitative decrease or a qualitative alteration of saliva. Lack of resting salivary flow or salivary gland dysfunction and hyposecretion results in quantitative change or the pH of saliva may fall to an acidic range that can alter the quality of saliva. These changes cause an alteration in a salivary composition that decreases the lubricating as well as mucoprotective qualities of saliva leading to oral symptoms of dryness often associated with oral burning [15, 16]. Subjective presentation of oral dryness is termed as xerostomia. Objectively, salivary flow can be measured by sialometry along with an extraoral and intraoral examination with the presentation of tenderness or fullness or salivary glands, clinical presentation of the dry mucosa, and fissured tongue with ropy or frothy saliva. A whole resting salivary flow at a rate of <0.1 ml/min and stimulated salivary flow rate <0.5 ml/minute is considered indicative of salivary gland hypofunction relative to the quantity of saliva [17]. An alteration on the quality of saliva may also affect the oral presentation when the pH of the saliva falls in the acidic range. The pH of saliva in a normal healthy individual ranges from 6.8 to 7.6, whereas acidic saliva below 5.5 can alter oral microbial flora and secondarily cause oral diseases such as dental caries, periodontitis, or oral candidal infection [18]. This review focuses primarily on oral burning; however, it is prudent to discuss oral dryness in the context of oral burning. The presentation of oral dryness especially with true salivary gland hypofunction can be very aggravating. Patients presenting with subjective xerostomia and objective hyposalivation report impaired quality of life. The presentation of oral dryness and associated oral burning in such scenarios may be related to underlying autoimmune conditions such as Sicca syndrome, Sjogren's syndrome, systemic lupus, and Flammer syndrome. Oftentimes, the oral dryness may present as a single yet striking condition primarily as an oral complaint than a systemic disease. In such situations, the oral dryness triggers the patients to seek care [19–21].

Oral burning from ill-fitting dental prosthesis

Ill-fitting dentures often add discomfort to routine activities involving the oral cavity or the head and neck region. Due to the instability, constant rubbing in mucosal surfaces creates friction and lesions including burning sensation. Occasionally, dentures may cause intense pressure points that

cause focal burning, and oral dysesthesia occasionally impacts taste and salivary dysfunction [12, 22].

Systemic etiological factors and comorbidities

Systemic factors potentially cause a reversible intraoral burning sensation. Various systemic factors are illustrated in Table 2, which highlights the systems involved with the presenting symptom, essential workup, and clinical approaches.

Nutritional deficiencies Measurement of iron, folate, ferritin, and vitamin B12 levels has been recommended as screening tests in patients with oral burning [23]. A strong association between hematinic deficiencies and oral burning has not been previously demonstrated [24]. According to a Mayo Clinic retrospective analysis of serological tests in patients with oral burning, deficiencies of vitamin B1, B2, B6, and zinc were associated with stomatodynia and recommended for screening patients with these symptoms [25].

Endocrinopathies There is weak evidence linking hypothyroidism with oral burning [26]. Similarly, uncontrolled diabetes may also be associated with oral burning and xerostomia [27]. However, burning mouth disorder is most prevalent in postmenopausal women, attributing to depletion of steroid sex hormones during menopause [28]. Similarly, hormone replacement therapy has not been shown to adequately control oral burning symptoms [29].

Medications Oral burning may be a side effect of medications such as angiotensin-converting enzyme inhibitors (ACEIs) [30]. Additionally, there are several medications implicated in taste alterations. Medications that cause dysgeusia [31] such as antibiotics, neurologic medications, cardiac medications, endocrine medications, and psychotropic medications [32] may be considered as possible causes of oral burning considering the overlap between burning mouth disorder and accompanying taste alterations.

Xerostomia induced by cancer therapy Patients undergoing or have undergone cancer therapy present a distinct set of oral complaints among which the oral discomfort from oral dryness, lesions, and burning sensation are discussed in this review. Dry mouth in these patients is associated with oral discomfort that can be described as a burning sensation [32] associated with chemotherapy or head and neck radiation. Chemotherapy may result in oral complications such as salivary gland hypofunction, oral mucositis, and oral ulceration that can cause severe oral burning. Hyposalivation is often an irreversible symptom of the head and neck radiation, even with targeted radiation therapies like intensity modulated radiation therapy (IMRT). Studies have demonstrated that lower radiation to the salivary glands has benefited reduction in

salivary gland hypofunction but has not totally eliminated. An IMRT with the total mean dose of less than <25 Gy demonstrated a significant reduction (<25%) of long-term salivary gland hypofunction when compared to traditional methods and higher levels of radiation [33]. Topical and systemic sialogogue, pilocarpine, and cevimeline use is associated with symptomatic relief and improved outcomes in patients with oral discomfort for xerostomia induced by cancer therapy [34].

Gastroesophageal reflux disease There is evidence linking gastroesophageal (GERD) in patients who experience oral burning [35]. Higher levels of *H. pylori* have been detected in patients with oral burning than in healthy controls [36]. Similarly, gastrointestinal problems were found to be commonly prevalent in patients with burning mouth disorder.

Autoimmune disease Symptoms of xerostomia and oral burning are present in patients suffering from autoimmune disease. The diagnosis of most autoimmune disorders is established based on respective diagnostic criteria and often take a few years before patients establish a definitive autoimmune diagnosis. Even prior to establishing diagnosis, patients may present with symptoms of oral dryness with or without oral burning, sometimes even as a primary presentation. In such scenarios, a workup to rule out autoimmune disease may be performed. Examples of such condition include Sjogren's syndrome, lupus, or Sicca syndrome [19, 21]. Patients with undergoing treatment for an autoimmune disease such as lupus or Sjogren's syndrome with corticosteroids or immunosuppressive agents may suffer from oral candidiasis which is often associated with oral burning and dysgeusia [20, 37]. Peripheral neuropathy from autoimmune disease may masquerade as glossodynia [20, 38]. Glossodynia and xerostomia are more prevalent and chronic in patients with fibromyalgia [39]. The management targets on focusing on etiological presentation, and oftentimes, neuropathic therapies are considered for management of oral burning.

Movement disorders Parkinson's and other neurologic movement disorders may affect the head and neck regions. Parafunctional habits from movement disorders like Parkinson's disease involving the tongue and lips may result in burning symptoms of the oral cavity [40]. Similarly, tardive dyskinesia-associated orofacial movement disorders may also be associated with oral burning [41].

Miscellaneous neuropathies Symptoms of oral burning and altered oral sensations have been reported in demyelinating conditions like multiple sclerosis, postherpetic neuropathy, and neuralgias [42]. Rarely, conditions like sarcoidosis, HIV, paraneoplastic phenomena, and amyloid deposits may cause neuropathies which manifest as oral burning [23].

Table 2 Systematic factors associated with chronic oral burning

Systematic factors	Conditions	Associated clinical presentation	Diagnostic investigations and presentation	Approaches in management
Nutritional factors	Anemia Dysgeusia, taste disturbances	Pale oral mucosa, tongue Mostly normal-looking oral tissues	Low iron, vitamin B12, folate, B complex Low zinc	<ul style="list-style-type: none"> • Treat the underlying cause • Symptomatic management with topical local anesthetic
Endocrine factors	Diabetes Pre-, peri-, or menopause Thyroid disease	Sometimes with dry mucosa and fissured tongue Mostly normal-looking oral tissues Mostly normal-looking oral tissues	Elevated blood glucose levels, HbA1C	<ul style="list-style-type: none"> • Treat the underlying cause • Symptomatic management with topical local anesthetic
Psychiatric disorders	Depressions, anxiety, obsessive compulsive disorder, somatoform disorder, cancerphobia, psychological stressor	Wear facets of teeth due to bruxism, prominent scalloping of tongue due to clenching, medication-induced xerostomia, myofascial pain of muscles of mastication, frictional areas of oral tissues due to parafunctional habits	None	<ul style="list-style-type: none"> • Treat the underlying cause • Symptomatic management with topical oral anesthetic
Neuropathy	Small cell neuropathy, diabetic neuropathy	Mostly normal-looking oral tissues sometimes with clinical evidence of oral dryness		<ul style="list-style-type: none"> • Treat the underlying cause • Symptomatic management with topical local anesthetic
Auto immune disease	Sjogren's syndrome	Oral burning secondary to salivary hypofunction	ANA, anti-SSA, anti-SSB	<ul style="list-style-type: none"> • Treat the underlying cause • Symptomatic management with topical local anesthetic
Medication-induced	ACE inhibitors, anti-hyperglycemics, chemotherapeutic agents	Mostly normal-looking oral tissues sometimes with clinical evidence of oral dryness or with salivary gland dysfunction	None	<ul style="list-style-type: none"> • Medication management if possible • Symptomatic management with topical local anesthetic

Psychological factors

Psychiatric conditions are frequently observed in oral burning. Several mechanisms including increased parafunctional oral habits such as clenching and bruxism, steroid dysregulation, central disinhibition to taste dysfunction, and low dopamine levels in the brain have been proposed as a possible cause in pathophysiology [39]. Anxiety-related oral parafunctional habits may manifest as oral burning secondary to the patient's habit of rubbing the tongue against the teeth and other parts of the oral cavity (Fig. 2). However, the relationship between BMS and psychological problems remains controversial. Sleep disturbance, chronic somatic pain, and mood disorders are closely associated. Studies show that patients with the primary oral burning show a significant decrease in sleep quality [43, 44].

Burning mouth syndrome

Burning mouth syndrome is a distinct neuropathy and may be an inaccurate empirical diagnosis in patients who present with oral burning secondary to other local and systemic factors. Primary BMS, also referred to as essential or idiopathic, is diagnosed after organic, local, and systemic etiologies of oral burning; cannot be identified; and is possibly transmitted by central and peripheral pathways of neuropathic pain. The International Association for the Study of Pain defines BMS as burning pain in the tongue or other oral mucous membrane associated with normal signs and laboratory findings lasting at least 4 to 6 months, without identifiable medical or dental causes [45]. BMS appears to be a multifactorial disease, and incomplete understanding of the etiology, pathophysiology, and diagnostic criteria is a barrier to critical investigation and selection of effective treatments. Various theories on pathophysiology have been reported in the literature while it is believed to be idiopathic with central and peripheral neuropathic changes [46–48]. Another etiopathological model is based on taste dysfunction, and pain interaction which hypothesizes that BMS could be the result of chemical, mechanical, or biological damage to the chorda tympani or glossopharyngeal nerve [49–52]. The clinical entity primary BMS encompasses at least three distinct, subclinical neuropathic pain statuses that may overlap in individual patients. The first subgroup (50–65%) is characterized by peripheral small-diameter fiber neuropathy of intraoral mucosa. The second subgroup (20–25%) consists of patients with subclinical lingual, mandibular, or trigeminal system pathology that can be identified with a careful neurophysiologic examination, but is clinically indistinguishable from the other two subgroups. The third subgroup (20–40%) fits the concept of central pain medication that may be related to hypofunction of dopaminergic neurons in the basal ganglia [53]. The overview of oral

burning in the context of burning mouth syndrome is illustrated in Fig. 4.

Clinical presentation and management of BMS

The symptomatology of burning mouth disorder is better characterized than oral burning secondary to other disorders. The spectrum of symptoms can range from chronic discomfort on the tongue, palate, labial mucosa, and palate, to a severe scalding sensation across the mouth. Variations have been documented in symptoms such as altered taste or altered sensation on the dorsal tongue. The severity of symptoms ranges from mild, moderate, severe to self-limiting symptoms to profound discomfort affecting the quality of life, to suicidal ideations. Xerostomia may be an additionally reported symptom. Occasionally, the onset of symptoms may be triggered by external stimuli such as oral infections or dental work. Chewing on soft food or cold substances may be associated with alleviation of symptom, and intake of spicy food, dental hygiene products, and stress may aggravate oral burning. Figure 1 illustrates a chief complaint of unilateral oral burning, with a history of bruxism and intraoral exam revealing wear facets of lower teeth and tongue displaying focal white plaque-like areas consistent with friction and irritation from sharp margins of teeth. Such lesions are often reversible by smoothing and polishing the cusps, preventing parafunctional oral habits, and providing occlusal splints. In the absence of a strong psychiatric trigger, the oral burning is minimized, but possibly occurs if the parafunctional habits return. The oral burning sensation may also occasionally be associated with oral candidal colonies causing an opportunistic infection that presents with oral burning and benign migratory glossitis [6, 54]. Tables 1 and 2 illustrate local and systemic factors respectively which contribute to oral burning. Table 3 describes management approaches in alleviating symptoms of oral burning secondary to BMS. The clinical feature of primary BMS includes a presentation of normal mucosa with oral burning that may be constant or episodic presenting on the tip of the tongue, lips, or cheeks or presenting as generalized oropharyngeal burning [55]. The approach to primary BMS targets to management and ease of symptom without a definitive cure which often includes a palliative and symptomatic management measure to neuro/psychomodulatory pharmacological and non-pharmacological therapies [56, 57].

Prediction, prevention, and personalization in patients with oral burning

Prediction Based on demographic and etiopathologic factors, oral burning and BMS demonstrate a predilection for female

Table 3 Management of primary burning mouth syndrome and secondary burning mouth that are not responsive to preliminary management

Management modalities

Single or multiple modalities to alleviate oral burning with treatment strategy focusing on palliative, symptomatic, and therapeutic measures

Pharmacological agents

(1) Topical

- Clonazepam orally disintegrating tablets/wafers/solution*
- Capsaicin**
- Doxepin 5%**
- Lidocaine**

(2) Systematic

- Alpha-lipoic acid*
- Tricyclic antidepressants**
- Antipsychotic agents (amisulpride*)
- Selective serotonin reuptake inhibitors (paroxetine*, sertraline**)
- Serotonin-adrenalin reuptake inhibitors**
- Anticonvulsants (e.g., gabapentin*)

Non-pharmacological therapy

- Oral splints**
- Cognitive behavioral therapy*
- Relaxation techniques**

*Recommendations based on randomized clinical trials

**Recommendations based on expert opinions

patients, especially in the perimenopausal state [4, 28]. Psychiatric and psychologic comorbidities such as anxiety and depression may present as strong predicting factors in patients with oral burning [58]. Patients demonstrating

diminished salivary flow due to reversible and irreversible causes may also predictably present with symptoms of oral burning [15]. A history of nutritional deficiencies [24] and endocrinopathies could be postulated as additional predictive factors [26]. The etiologic factors for oral burning outlined in Tables 1 and 2 may be considered as potential predictors for this condition.

Prevention Mitigation of anxiety and psychological issues are associated with improved treatment outcomes in burning mouth syndrome. The findings of high levels of psychological disturbances involving depression, anxiety, somatization, and personality disorders are not unusual or unique to BMS patients [59]. As with other chronic pain conditions, axis II disorders comprising psychosomatic comorbidities may aggravate existing underlying neuropathies, such as BMS [59, 60]. Addressing underlying psychosomatic conditions which aggravate oral burning may be hypothesized as a preventive management modality in patients experiencing these symptoms [61]. Patients with unmitigated oral burning have a history of seeing multiple providers for their condition with inadequate symptomatic resolution; focused counseling and patient education may improve their quality of life, thereby preventing symptoms from getting worse [62]. Oral burning secondary to systemic and local etiologic factors (Tables 1 and 2) may be prevented by addressing the underlying cause of oral burning, if identified [58, 62]. Management of xerostomia may cause improved outcomes in some patients, but

Fig. 5 Diagnosis and management of a patient with oral burning

normalizing salivary flow may not prevent oral burning completely [63, 64].

Personalization Oral burning symptoms are challenging to diagnose and manage and often require an adequate team-based approach of patient care. Patients may find symptoms difficult to elucidate, and providers may be unfamiliar with them due to the low prevalence of oral burning. Patients who suffer from oral burning consult an average of three providers over an average of 13 months before their symptoms are appropriately diagnosed and managed [65]. Inadequate or inappropriate care can further exacerbate patient symptoms [65]. Personalization of patient care can be obtained by thorough history, examination, and diagnostic tests to identify local and systemic causes of oral burning. Figure 5 depicts an algorithm to personalize diagnosis, investigative techniques, and treatment modalities of patients with oral burning. If a diagnosis of BMS is made by ruling out other etiologies of oral burning, management typically involves topical and systemic neuro-pathic or desensitizing agents [58]. Table 3 outlines a summary of pharmacologic management techniques in patients diagnosed with BMS. Patients with oral burning may be referred to oral medicine and orofacial pain dental specialists for management [66].

Limitations and future research

A universally accepted definition of BMS [46] could help assist diagnosis [42] and could possibly separate other causes of oral burning from BMS. Mechanisms of peripheral neuropathy in patients with BMS may lead to future therapeutic interventions for this condition. Artemin (Atn) upregulates the expression of transient receptor potential vanilloid 1 (TRPV1) [42], and expression of both Atn and TRPV1 has been demonstrably higher in patients with BMS compared to controls [49, 67]. Recent therapeutic interventions showing favorable results in managing BMS symptoms include melatonin [68] and an herbal supplement, catauma [69]. Cognitive behavioral therapy in patients with BMS which manages depression, anxiety, and somatic symptoms may be associated with improved therapeutic outcomes [70]. Future research in the areas of etiology and management of oral burning, along with universally accepted diagnostic criteria for BMS, could show promising results in PPPM interventions in this patient cohort.

Conclusion and expert recommendations

Oral burning can occur due to a variety of local and systemic causes, in addition to the oral neuropathic disorder burning mouth syndrome. Patients may seek help from medical and dental providers from various specialties for their symptoms,

which may negatively impact their quality of life. This mini-review highlights the diverse presentation of oral burning and its diagnostic and management approaches applying the PPPM strategy. Oral burning symptoms warrant a personalized approach in recognizing their underlying cause which dictates appropriate management and referral. Identifiable causes of oral burning should be addressed whenever possible. A team-based approach in patient care involving medical providers, along with oral medicine and orofacial pain specialists, may be associated with the most desirable outcomes.

Compliance with ethical standards

Conflicts of interest The submitted documents represent original work that has not been published previously. The manuscript is not currently submitted for publication elsewhere. All authors have read and approved the manuscript. We also report no conflicts of interest.

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